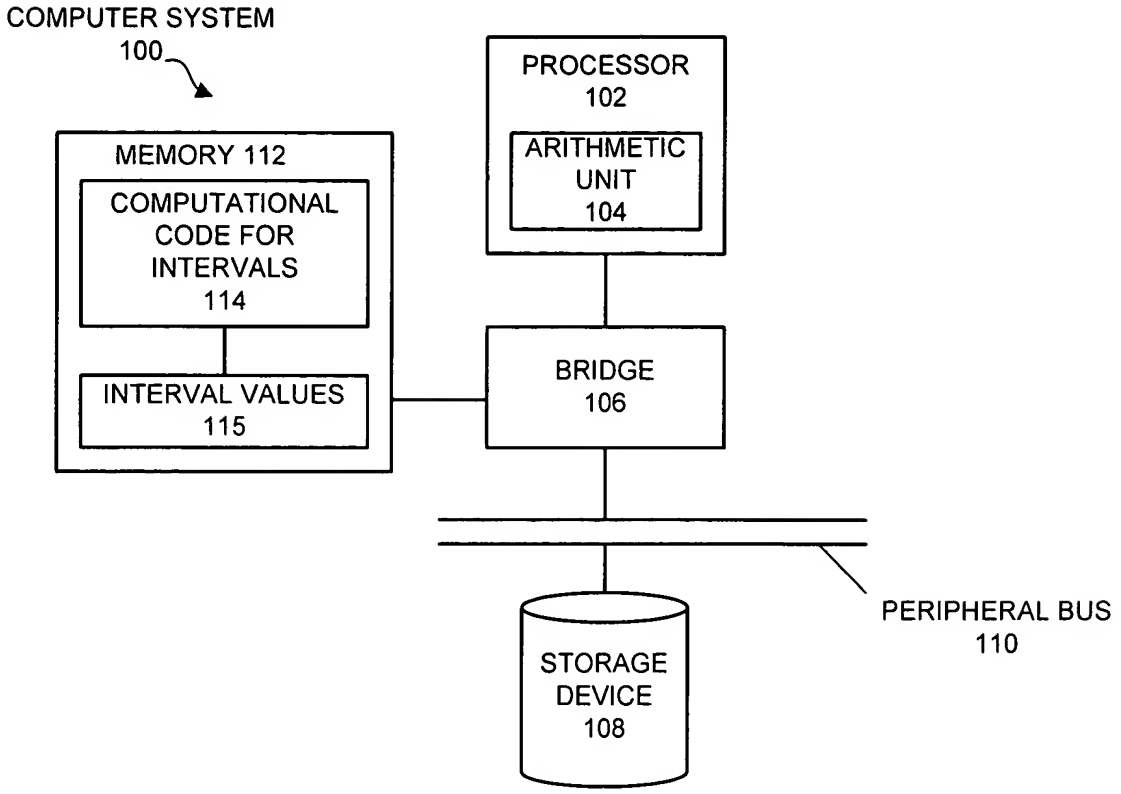
COMPUTER SYSTEM
100
PROCESSOR
102
ARITHMETIC
UNIT
104
MEMORY 112
COMPUTATIONAL
CODE FOR
INTERVALS
114
INTERVAL VALUES
115
BRIDGE
106
PERIPHERAL BUS
110
STORAGE
DEVICE
108

FIG. 1

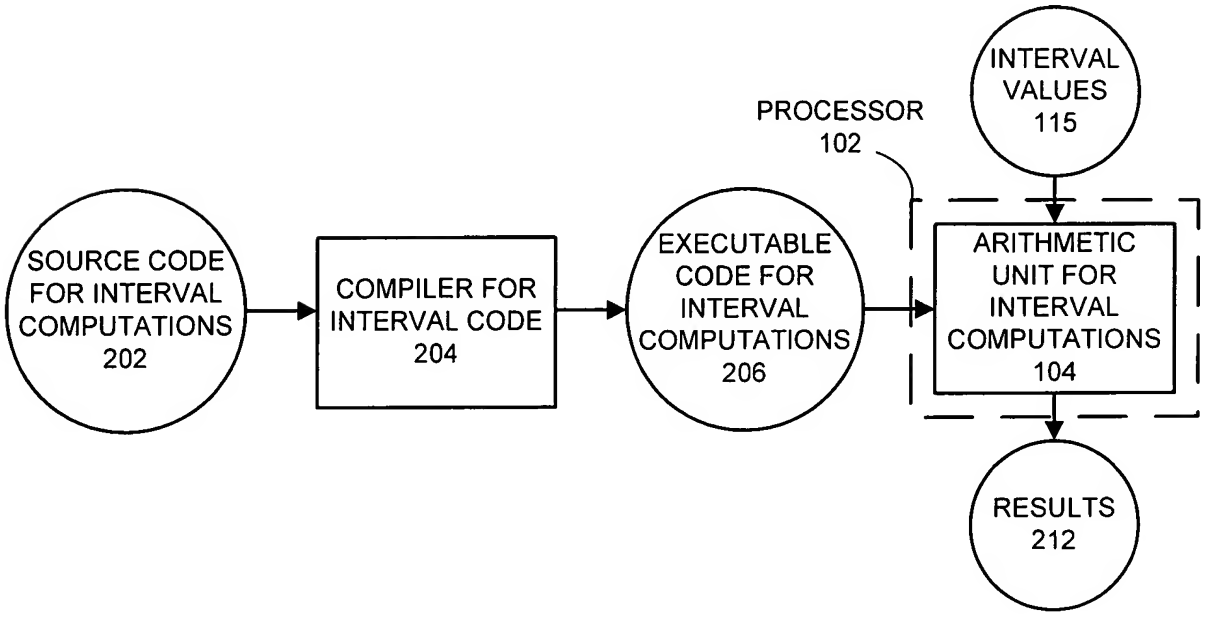
INTERVAL
VALUES
115
PROCESSOR
102
SOURCE CODE
FOR INTERVAL
COMPUTATIONS
202
COMPILER FOR
INTERVAL CODE
204
EXECUTABLE
CODE FOR
INTERVAL
COMPUTATIONS
206
ARITHMETIC
UNIT FOR
INTERVAL
COMPUTATIONS
104
RESULTS
212

FIG. 2

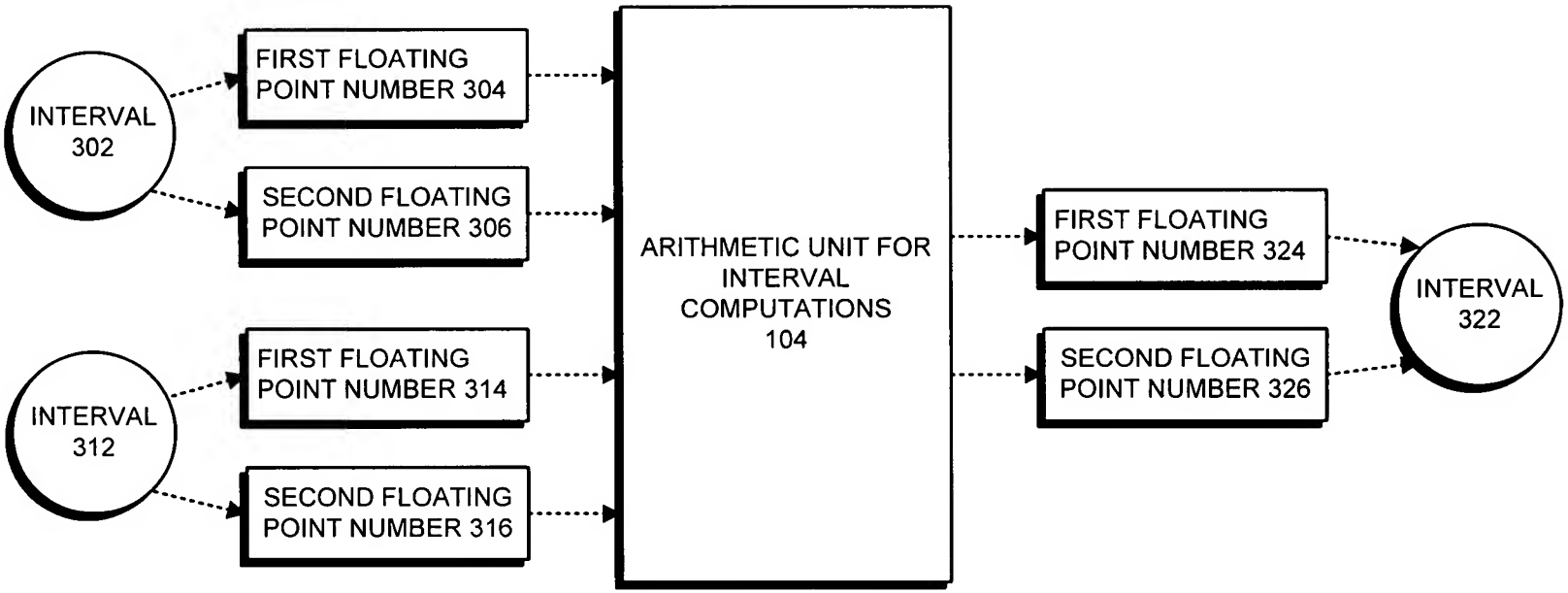
INTERVAL
302
FIRST FLOATING
POINT NUMBER 304
SECOND FLOATING
POINT NUMBER 306
INTERVAL
312
FIRST FLOATING
POINT NUMBER 314
SECOND FLOATING
POINT NUMBER 316
ARITHMETIC UNIT FOR
INTERVAL
COMPUTATIONS
104
FIRST FLOATING
POINT NUMBER 324
SECOND FLOATING
POINT NUMBER 326
INTERVAL
322

FIG. 3

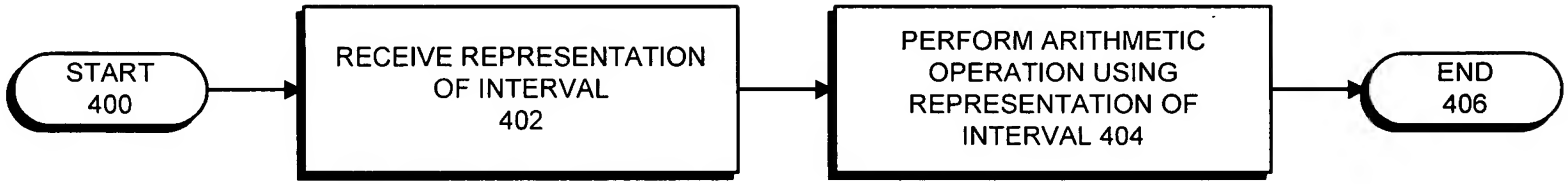
START
400
RECEIVE REPRESENTATION
OF INTERVAL
402
PERFORM ARITHMETIC
OPERATION USING
REPRESENTATION OF
INTERVAL 404
END
406

FIG. 4

$$X \equiv \left[\underline{x}, \bar{x}\right] \equiv \left\{x \in \Re^* \mid \underline{x} \le x \le \bar{x}\right\}$$

$$Y \equiv \left[\underline{y}, \bar{y}\right] \equiv \left\{y \in \Re^* \mid \underline{y} \le y \le \bar{y}\right\}$$

(1) $$X + Y = \left[\downarrow \underline{x} + \underline{y}, \uparrow \bar{x} + \bar{y}\right]$$

(2) $$X - Y = \left[\downarrow \underline{x} - \bar{y}, \uparrow \bar{x} - \underline{y}\right]$$

(3) $$X \times Y = \left[\min\left(\downarrow \underline{x} \times \underline{y}, \underline{x} \times \bar{y}, \bar{x} \times \underline{y}, \bar{x} \times \bar{y}\right), \max\left(\uparrow \underline{x} \times \underline{y}, \underline{x} \times \bar{y}, \bar{x} \times \underline{y}, \bar{x} \times \bar{y}\right)\right]$$

(4) $$X / Y = \left[\min\left(\downarrow \underline{x} / \underline{y}, \underline{x} / \bar{y}, \bar{x} / \underline{y}, \bar{x} / \bar{y}\right), \max\left(\uparrow \underline{x} / \underline{y}, \underline{x} / \bar{y}, \bar{x} / \underline{y}, \bar{x} / \bar{y}\right)\right], \text{if } 0 \notin Y$$

$$X / Y \subseteq \Re^*, \text{if } 0 \in Y$$

FIG. 5

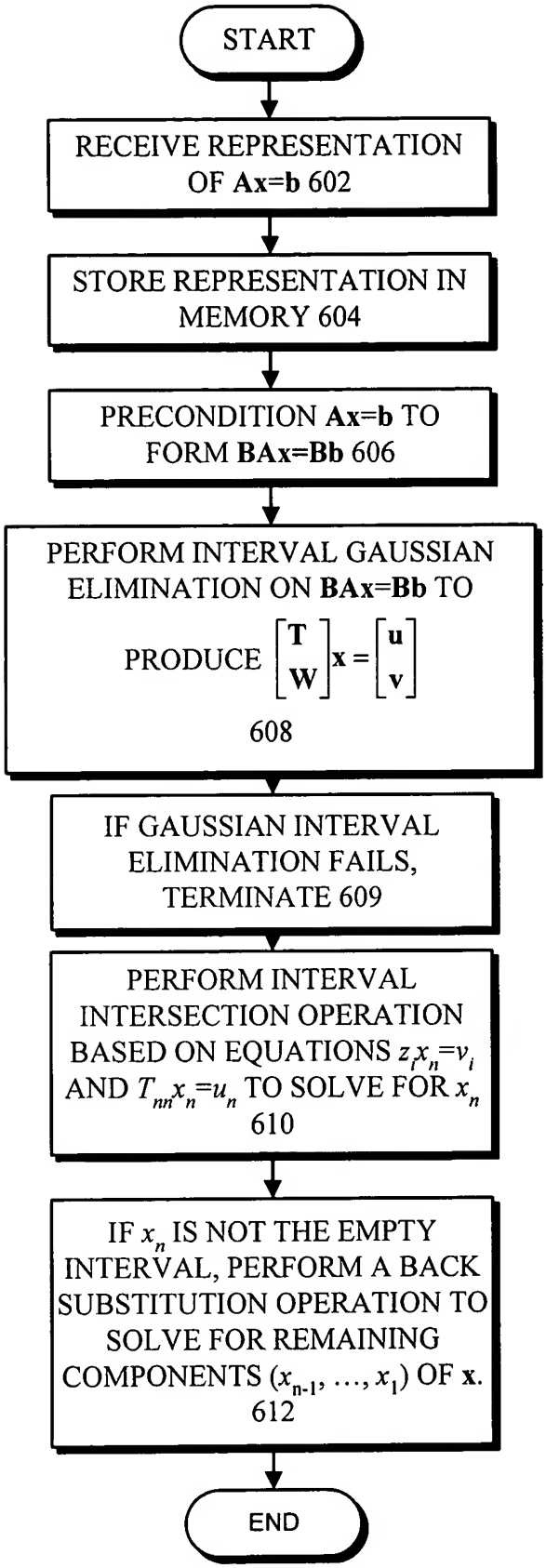
START
RECEIVE REPRESENTATION OF Ax=b 602
STORE REPRESENTATION IN MEMORY 604
PRECONDITION Ax=b TO FORM BAx=Bb 606
PERFORM INTERVAL GAUSSIAN ELIMINATION ON BAx=Bb TO PRODUCE $\begin{bmatrix} \mathbf{T} \\ \mathbf{W} \end{bmatrix} \mathbf{x} = \begin{bmatrix} \mathbf{u} \\ \mathbf{v} \end{bmatrix}$ 608
IF GAUSSIAN INTERVAL ELIMINATION FAILS, TERMINATE 609
PERFORM INTERVAL INTERSECTION OPERATION BASED ON EQUATIONS $z_i x_n = v_i$ AND $T_{nn} x_n = u_n$ TO SOLVE FOR x_n 610
IF x_n IS NOT THE EMPTY INTERVAL, PERFORM A BACK SUBSTITUTION OPERATION TO SOLVE FOR REMAINING COMPONENTS $(x_{n-1}, \ldots, x_1)$ OF x. 612
END

FIG. 6

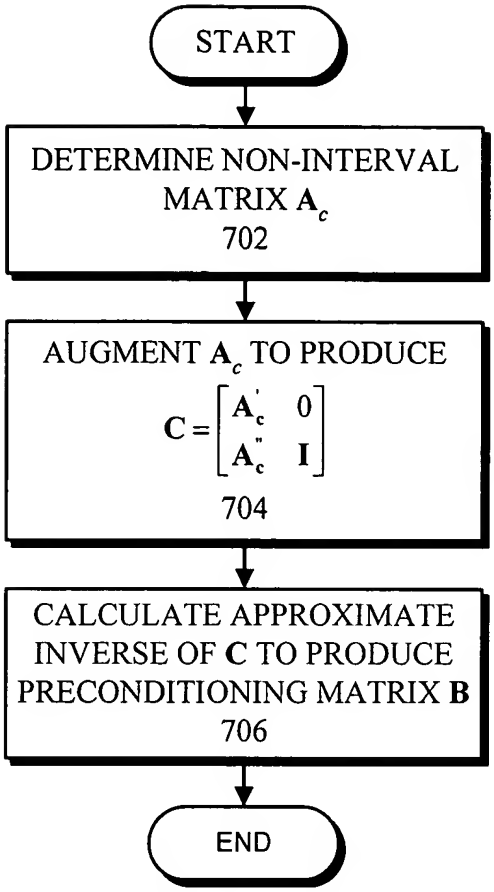
START
DETERMINE NON-INTERVAL MATRIX A_c
702
AUGMENT A_c TO PRODUCE
$C = \begin{bmatrix} A_c' & 0 \\ A_c'' & I \end{bmatrix}$
704
CALCULATE APPROXIMATE INVERSE OF C TO PRODUCE PRECONDITIONING MATRIX B
706
END

FIG. 7

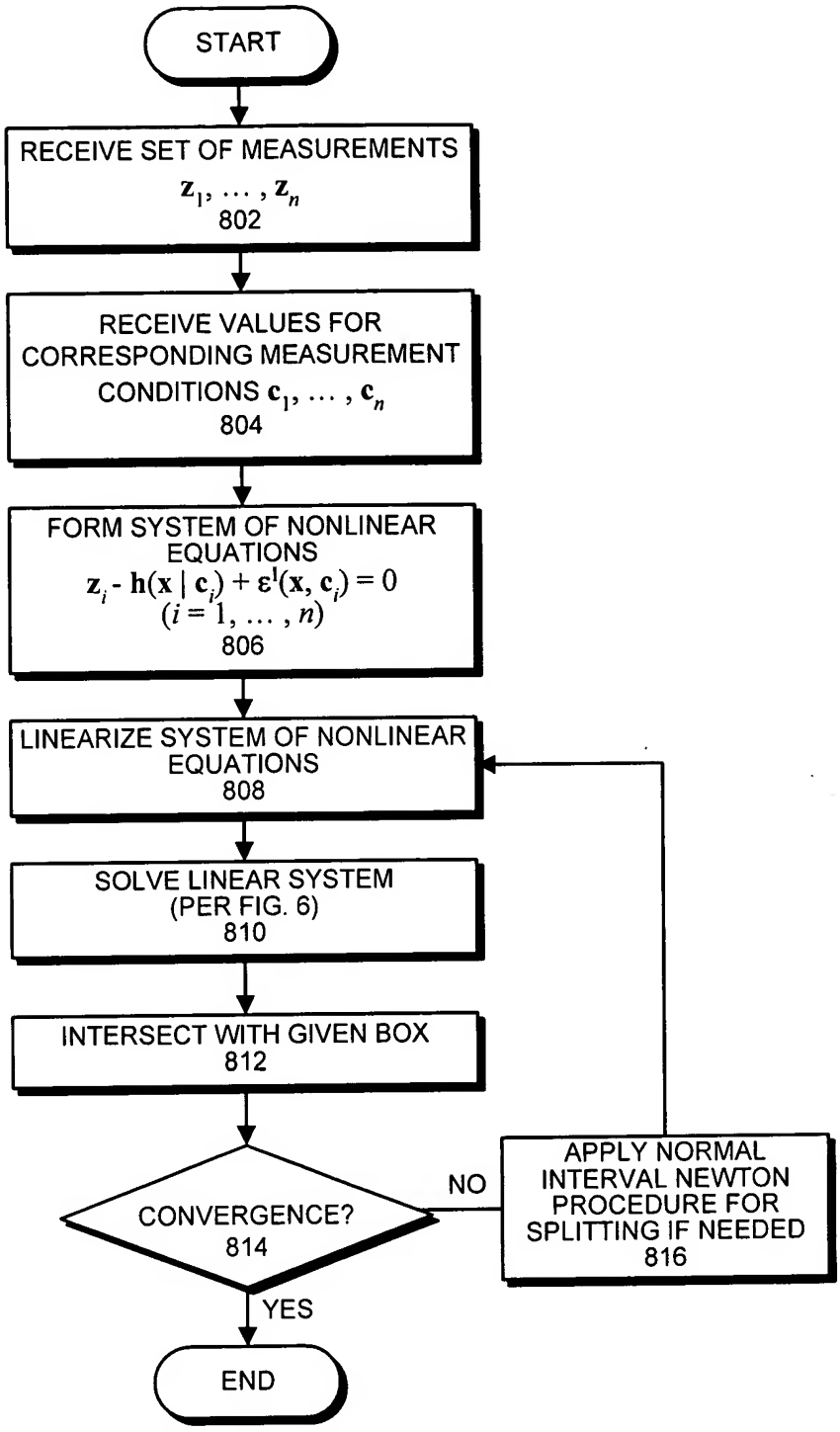
START
RECEIVE SET OF MEASUREMENTS
$\mathbf{z}_1, \ldots, \mathbf{z}_n$
802
RECEIVE VALUES FOR CORRESPONDING MEASUREMENT CONDITIONS $\mathbf{c}_1, \ldots, \mathbf{c}_n$
804
FORM SYSTEM OF NONLINEAR EQUATIONS
$\mathbf{z}_i - \mathbf{h}(\mathbf{x} \mid \mathbf{c}_i) + \varepsilon^I(\mathbf{x}, \mathbf{c}_i) = 0$
$(i = 1, \ldots, n)$
806
LINEARIZE SYSTEM OF NONLINEAR EQUATIONS
808
SOLVE LINEAR SYSTEM (PER FIG. 6)
810
INTERSECT WITH GIVEN BOX
812
CONVERGENCE?
814
NO
APPLY NORMAL INTERVAL NEWTON PROCEDURE FOR SPLITTING IF NEEDED
816
YES
END

FIG. 8